

POSTER PAPER

Gemini GMOS IFU Spectroscopy of IRAS 04505-2958: A New Exploding BAL + IR + Fe II QSO

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Abstract. New results of a Gemini GMOS Programme of study of BAL+ IR+ Fe II QSOs are presented. We have performed a study of the kinematics, morphological, and physical conditions, in the BAL-QSO: IRAS 04505-2958. From this study, selected results are presented, mainly for the three more internal expanding shells. In particular, the GMOS data suggest that the outflow processes –in this QSO– generated multiple expanding hypergiant shells (from ~ 10 , to ~ 100 kpc), in several extreme explosive events. These new GMOS data are in good agreement with our evolutionary, explosive and composite model: where part of the ISM of the host galaxy is ejected in the form of multiple giant shells, mainly by HyN explosions. This process could generate satellite/companion galaxies, and even could expel a high fraction –or all– the host galaxy. In addition, this Model for AGN could give important clues about the origin –in AGNs– of very energetic cosmic rays, observed by the P. Auger Observatory

Resumen. Nuevos resultados de un programa Gemini GMOS de estudio de BAL + IR + Fe II QSOs son presentados. Nosotros estudiamos la morfología, cinemática y condiciones físicas de IRAS 04505-2958. Resultados selectos de este estudio se presentan en este trabajo, sobre 3 de sus burbujas en expansión. Estos datos muestran un buen acuerdo con nuestro Modelo evolutivo, explosivo y compuesto de AGNs/QSOs. Este modelo explosivo de AGN podría darnos claves sobre el origen –en AGN– de los rayos cósmicos detectados por el Observatorio P. Auger.

1. Introduction, The Programme, and Observations

There is increasing evidence that galactic outflow (OF), broad absorption lines (BALs) and explosive events (ExE) play a main role, specially when the galaxies and QSOs formed (see Lipari et al. 2007).

1.1. Explosive BAL + IR + Fe II QSOs. The presence of *extreme explosions and OF* –associated mostly to the end of extreme massive stars– is an important component for different theoretical models of galaxy/QSO evolution (see Lipari et al. 2007). From the observational point of view, the presence of multiple

concentric expanding supergiant bubbles/shells in young composite BAL + IR + Fe II QSOs, with centre in the nucleus and with highly symmetric circular shape could be associated mainly with giant symmetric explosive events (Lipari et al 2003). These explosive events could be explained in a composite scenario: where the interaction between the starburst and the AGN could generate giant explosive/HyperNova (HyN) events (see Collin & Zahn 1999).

1.2. Evolutionary, Explosive and Composite Model for QSOs/AGNs.

An evolutionary, explosive and composite scenario was proposed for BAL + IR + Fe II QSOs (Lipari 1994, Lipari et al. 2005, Lipari & Terlevich 2006). Where mergers fuel extreme star formation processes and AGNs, resulting in strong dust and IR emission, large number of SN and HyN events, with expanding super giant bubbles/shells.

1.3. IRAS 04505-2958. This IR source was associated with a luminous quasar ($M_V = -25.8$) at $z = 0.286$. The first optical images and spectroscopy showed a bright nucleus, a close foreground G star (at $2''$ to the NW, from the nucleus) plus a possible tidal tail to the SE (at $\sim 2''$). HST WFPC2 images show that the possible SE “tail” is a very complex structure. Lipari et al. (2003) suggested that the SE tail/ring like structure is probably a large scale (30 kpc) external expanding shell, at $r \sim 11$ kpc. The BAL system in this IR QSO was discovered by Lipari et al.(2005) based on the evolutionary IR colour-colour diagram (Fig. 15 in their paper). Notably, the BAL shows the same blueshift as the main OF.

1.5. Gemini GMOS-IFU and HST Observations. This study is based on Gemini integral field spectroscopy, combined with Hubble Space Telescope images. 3D deep optical spectroscopy of the nuclei and the 3 more internal arcs of IRAS 04505–2958 were obtained during 4 nights in 2005 and 2007, at Gemini South. The telescope was used with the Multi-Object Spectrograph (GMOS).

2. The Hypergiant Shells System of IRAS 04505-2958: Gemini + HST Evidence of Multiple Hyper-explosive Events.

2.1. Previous Works.

Shells S1 and S2: From a study of host galaxies in QSOs, Magain et al. (2005) detected a blob close to IRAS 04505-2958, about $0.3''$ to the north-west; without other clear evidence of the host galaxy. In the present GMOS study we found that this blob is composite by 2 shells (S1 and S2) of $r \sim 0.2, 0.4''$ (1.1, 2.2 kpc).

Shell S3: From a study of HST images + CASLEO spectra of IRAS 04505–2958, we proposed that this extended/hyper shell was generated by explosive events with **composite hyperwinds** (Lipari et al. 2003, 2005).

Shell S4: A study of a very clear external supergiant shell at $r \sim 15''$ (~ 80 kpc) is actually in progress. The study of the very extended shells S4 and S3 is important for the analysis of the origin of the extended Ly α blobs at high redshift (Lipari & Terlevich 2006).

2.2. Gemini Results. Fig. 1a presents high resolution HST WFPC2 broadband image/contours obtained in the optical wavelengths through the filter WF2-F702W. This HST image shows: the QSO, the main concentric shell S3, and the field G star. In addition, Figs. 1a shows the observed GMOS field (~ 20 kpc \times 28 kpc). The GMOS frame was centred close to the middle position between the QSO and S3, at the PA $\sim 311^\circ$. Fig. 1b shows the [S II]/H α GMOS map.

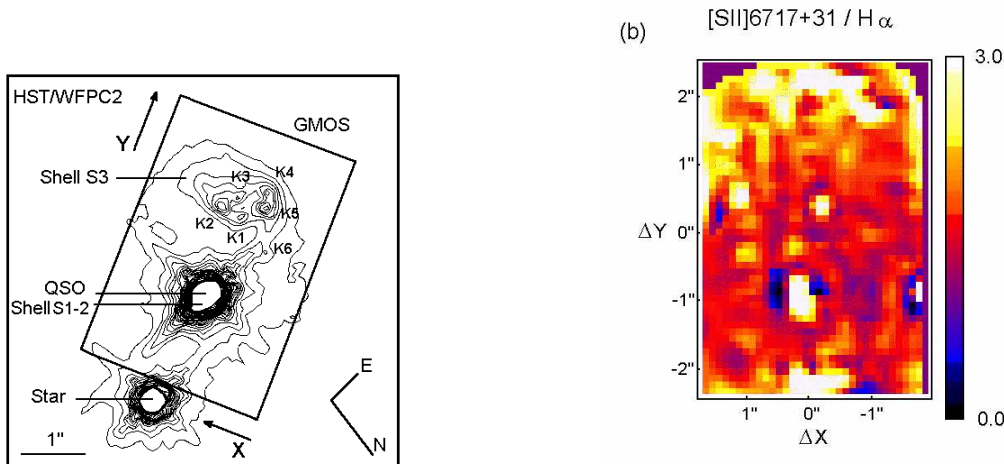


Figure 1. *Left:* HST WFPC2 Deep R Contour + GMOS field.
Rigth: $[S II]6717+31 / H\alpha$ GMOS map.

Shell S3: Fig. 1a shows the very extended morphology of the main super giant shell. This plot was performed using a scale of fluxes starting from very low values. This very deep figure shows almost the complete emission of S3, which shows highly symmetric and circular shape, with center in the QSO.

Here, we remark some interesting properties found using the GMOS-3D spectra, the emission line and kinematics maps: (i) all the GMOS field –including S3– depicts very extended emission line and also blue continuum (at scale of ~ 15 -20 kpc around the QSO); (ii) the knots of the shell S3 show multiple emission lines with Liner properties, which are associated with shock processes. Furthermore, the $[S II]/H\alpha$ map (Fig. 1b) shows the typical arc structures associated with the external shocks, of the shells S3 and S2; (iii) the kinematics of these emission lines is in agreement with extreme explosive/OF processes.

Lipari et al. (2007) already proposed that the GMOS results obtained for shell S3 show properties typical of: an expanding shell, and also of a companion/satellite galaxy. This fact is in good agreement with the prediction of theoretical explosive models for formation of galaxies/QSOs (proposed by Ikeuchi; Ostriker et al.).

Shells S1 and S2: The GMOS spectra, the physical condition diagrams and the kinematics maps show also very interesting properties of these 2 internal shells: multiple emission lines with Liner properties (associated with shocks); plus the kinematics is consistent with this explosive scenario.

3. Conclusion about IRAS 04505-2958 and the Explosive Model.

3.1. IRAS 04505-2958 and the concept of Galaxy Remnant/End.

A very interesting point about IRAS 04505-2958 is the fact that though shell S3 is clearly observed, at the same redshift the host galaxy of this QSO remains undetected, in spite of the very careful image analysis. Multiple explosive events expelling a high fraction of the host galaxy could be a possible explanation.

Several explosive events can eject a high fraction of the ISM; this process would play a main role in the evolution of the star formation, finally defining the mass of the remnant of the original galaxy. We call a galaxy remnant this end product of the multiple explosive processes. We believed that in IRAS 04505-2958 we are observing for the first time a candidate of a galaxy in the end phase (via explosions), and/or a remnant.

3.2. Cosmic Rays Associated with AGNs/QSOs: the new data from the P. Auger Observatory. Recently an important result was obtained at P. Auger (Abraham et al. 2007). They found that the cosmic rays (CR) with very high energy are associated with AGNs. There are mainly two Models of AGNs/QSOs, which could explain these observations: (i) Obscured and Collimated AGN/Black-Hole; (ii) Evolutionary, Explosive, and Composite Model.

The production of relativistic electrons is in young SN remnants and it is believed that remnants simultaneously produce relativistic ions/CRs (see Ellison et al. 2007). On the other hand, in the evolutive model for AGNs, HyN explosions are a main component; thus we suggest that giant remnants of HyN explosions (that we call RHyN) could be a natural candidate for the origin –in AGNs– of very energetic CRs. In addition, it is important to note that also the large duration and very energetic gamma ray bursts are associated mainly with HyN explosions.

3.3. Dark Matter in IR Mergers and BAL + IR + FeII QSOs. There are two interesting points about the relation of these BAL QSOs and dark matter: First, the sequence of these QSOs –in the evolutionary IR colour-colour diagram– start in IR Mergers with strong OF. Our detailed 3D spectroscopic kinematical study of IR Mergers + OF (like NGC 3256, NGC 2623, etc) show mainly sinusoidal radial velocity curve. We already discussed the possibility that the dark matter is absent in these IR Mergers (Lipari et al. 2004).

Second, it is important to remark that in the last decades the neutrinos were considered as a probable candidate for dark matter, but it is not clear their origin. Recently, the discovery of the most luminous SNe: 2006GY, 2006TF, 2005AP, which are powered by the death of extremely massive star strongly suggest that the neutrinos generated by HyN –and primordial HyN– could be considered as a candidate for the origin of at least part of the dark matter.

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